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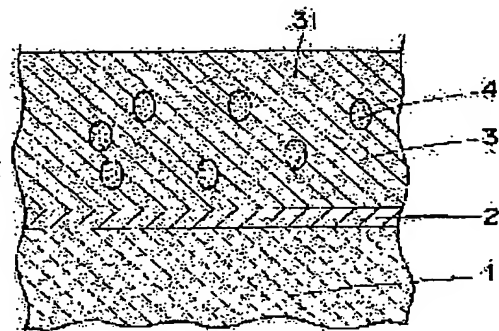
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(54) PLATING MAGNETIC ALLOY FILM, ITS MANUFACTURING METHOD, AND MAGNETIC ALLOY PLATING SOLUTION USED FOR THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an electroplating method of manufacturing a plating magnetic alloy film, which is high in resistivity and used for a thin-film magnetic head that is used for a magnetic recording reproducing device.

SOLUTION: A plating magnetic alloy film, formed on a board, is composed of a magnetic alloy and metal oxide separated in an eutectoid manner in the magnetic alloy. The magnetic alloy film is formed on the board by plating in a magnetic alloy plating solution composed of a magnetic metal component-containing solution and metal oxide or metal hydroxide dissolved in it, when the magnetic alloy film is plated on a conductive or nonconductive board through an electroplating method. The plating magnetic alloy film is used as a magnetic core for a thin-film magnetic head, by which the magnetic head can be improved in high-frequency characteristic.



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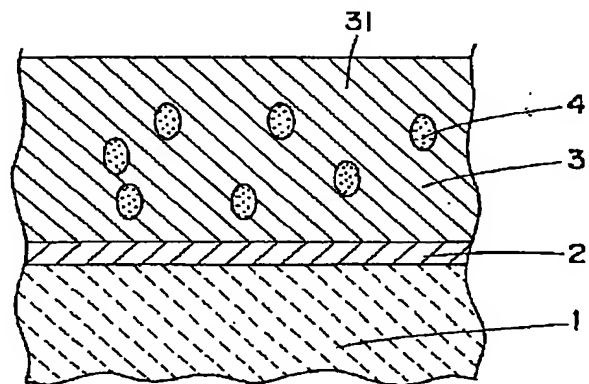
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(54) 【発明の名称】 めっき磁性合金膜とその製造方法およびその方法に用いる磁性合金めっき液

(57) 【要約】

【課題】 電気めっきにより形成されるめっき磁性合金膜に関し、磁気記録再生装置などに用いる薄膜磁気ヘッドおよびその磁気コアに用いる磁性合金膜に関する。比抵抗の高いめっき磁性合金膜を電気めっき法で提供する。

【解決手段】 基板上に形成されためっき磁性合金膜が、磁性合金と、磁性合金中に共析した金属酸化物と、から構成する。その製造は、導体あるいは非導体基板上に電気めっき法により磁性合金膜をめっきするに際して、磁性金属成分含有溶液中に金属酸化物若しくは金属水酸化物とを含有する磁性合金めっき液中で、上記基板上に磁性合金膜をめっき形成する。このめっき磁性合金膜を薄膜磁気ヘッドの磁気コアとして用いることにより磁気ヘッドの高周波特性が改善される。



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CLAIMS

[Claim(s)]

[Claim 1]A plating magnetic alloy film formed on a substrate, comprising:

A plating magnetic alloy film is a magnetic alloy.

Metallic-oxide material which carried out the eutectoid into a magnetic alloy.

[Claim 2]The plating magnetic alloy film according to claim 1 in which a metallic oxide is characterized by having specific resistance higher than a magnetic alloy.

[Claim 3]The plating magnetic alloy film according to claim 1 or 2, wherein a metallic oxide is an oxide which contains aluminum or silicon in the main ingredients.

[Claim 4]The plating magnetic alloy film according to any one of claims 1 to 3, wherein magnetic alloy material is an alloy which contains iron at least as ferromagnetic metal, and contains nickel or cobalt further.

[Claim 5]A thin film magnetic head, wherein a magnetic core of a thin film magnetic head comprises the plating magnetic alloy film according to any one of claims 1 to 4.

[Claim 6]A manufacturing method of a magnetic alloy film which plates a magnetic alloy film with electroplating on a substrate of a conductor or a non-conductor characterized by comprising the following.

Plating formation of the magnetic alloy film is carried out on the above-mentioned substrate in magnetic alloy plating liquid which contains a metallic oxide or metal hydroxide in a magnetic metal ingredient content solution, and this plating magnetic alloy film is a magnetic alloy.

Metallic-oxide material which carried out the eutectoid into a magnetic alloy.

[Claim 7]The manufacturing method according to claim 6 forming an electrode layer for plating in the above-mentioned substrate beforehand, and forming a plating magnetic alloy film on this electrode layer.

[Claim 8]The manufacturing method according to claim 6 or 7 with which a metallic oxide is characterized by having specific resistance higher than a magnetic alloy.

[Claim 9]A manufacturing method given in claims 6 thru/or 8, wherein a metallic oxide or metal hydroxide is a compound which contains aluminum or silicon in the main ingredients.

[Claim 10]A manufacturing method given in claims 6 thru/or 9, wherein magnetic alloy material is an alloy which contains iron at least as ferromagnetic metal, and contains nickel or cobalt further.

[Claim 11]A manufacturing method given in claims 6 thru/or 10, wherein the above-mentioned plating is made with rectangular wave pulse current.

[Claim 12]Magnetic alloy plating liquid which is alloy-plating liquid used in order to form a magnetic alloy film by electroplating on a substrate, and is characterized by this plating liquid containing a metallic oxide or metal hydroxide in a magnetic metal ingredient water content solution.

[Claim 13]The magnetic alloy plating liquid according to claim 12, wherein a metallic oxide or metal hydroxide added in alloy-plating liquid is based on aluminum.

[Claim 14]Claim 12 or magnetic alloy plating liquid of a statement of 13, wherein a metallic oxide or metal hydroxide added in alloy-plating liquid is based on silicon.

[Claim 15]Magnetic alloy plating liquid given in claims 12 thru/or 14, wherein alloy-plating liquid contains iron at least as a magnetic metal and contains at least one of nickel and the cobalt further.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention]This invention relates to the manufacturing method of the magnetic alloy film by electroplating, and the plating liquid used for it about the plating magnetic alloy film formed of electroplating. It is related with the magnetic alloy film used for the thin film magnetic head especially used for a magnetic recorder and reproducing device etc., and its magnetic core.

[0002]

[Description of the Prior Art]The magnetic thin film formed from electroplating is used for the thin film magnetic head used for a magnetic recorder and reproducing device etc., and its magnetic core. For example, as a magnetic core material of the recording part of a thin film magnetic head, nickel-Fe alloy of the presentation of nickel 80% - near 50% is used widely.

[0003]As the structure of the conventional thin film magnetic head shows drawing 2 the Records Department, the recording gap 22, the thin film coil 23, and the coil insulation layer 24 are formed on the common magnetic shielding 21, and the upper magnetic core 25 is formed. As for the upper magnetic core 25, the part is connected with the above-mentioned common shield 21, and the upper magnetic core 25 and the common shield 21 form the magnetic core for magnetic recording. The plating magnetic alloy film is applied when forming the common magnetic shielding 21 and the upper core 25 with a film method.

[0004]The thin film magnetic head used for it is also expected various highly efficient-ization with highly-efficient-izing of a magnetic disk drive. For example, the necessity of making it high asks for the write frequency for improvement in surface recording density, and it in this case, Since amplitude permeability falls remarkably, recording magnetic field strength falls and the phase lag of a generating magnetic field becomes remarkable by the eddy current loss in a magnetic material in a high frequency range, as for the thin film magnetic body, it is known that the recording characteristic of a magnetic head will deteriorate. In order to reduce eddy current loss,

to insert an insulating layer between magnetic layers is validated as indicated by JP,08-102013,A.
[0005]

[Problem(s) to be Solved by the Invention]However, when manufacturing the magnetic core of a thin film magnetic head with electroplating, the method of making this insulating layer intervene is not practical. Only in electroplating, it is because the cascade screen of a magnetic alloy film and an insulator film cannot be built, so it will be used by turns, electroplating, and other insulator formation methods, for example, weld slag, and becomes very complicated on a process.

[0006]The specific resistance of an alloy of the above-mentioned nickel-Fe alloy is 20 - 40microomegacm, and the value is not large. For this reason, eddy current loss is large, and as mentioned above, for the improved efficiency in the high frequency range of a magnetic head, it is required that the resistivity of the plating magnetic alloy film which constitutes a magnetic core should be raised.

[0007]For this reason, this invention tends to provide the high plating magnetic alloy film of specific resistance with electroplating in view of the above-mentioned problem. The magnetic cores of the recording part of a thin film magnetic head are presented especially with this invention, and it tends to provide the magnetic alloy film it is large, and magnetic loss is small, and ***** excelled [film] in the magnetic properties in the high frequency region.

[0008]

[Means for Solving the Problem]A plating magnetic alloy film of this invention is a plating magnetic alloy film formed on a substrate, and makes ***** with the feature metallic-oxide material in which a plating magnetic alloy film carried out the eutectoid into magnetic alloy material and magnetic alloy material. This magnetic alloy film raises specific resistance of the whole magnetic alloy film by carrying out the eutectoid of the metallic-oxide material finely into a magnetic alloy.

[0009]When it electroplates on a substrate, a manufacturing method of such a plating magnetic alloy film adds metallic-oxide material in plating liquid, and a plating layer is deposited simultaneously and it makes a magnetic alloy and metallic-oxide material it at a plating film. Plating liquid used for this manufacturing method adds metallic-oxide material further by using as the main ingredients what dissolved a constituent element of a magnetic alloy.

[0010]A high resistance plating magnetic alloy film of this invention can be widely used for other magnetic cells of thin film ferromagnetism as a magnetic shielding film as an object for reproduction of a magnetic head, or a magnetic core for record. A plating magnetic alloy film of this invention is used for the magnetic cores for record of a thin film magnetic head, and a magnetic alloy film forms a magnetic core it is large, and magnetic loss is small, and specific resistance excelled [magnetic core] in magnetic properties in a high frequency region.

[0011]

[Embodiment of the Invention]The plating magnetic alloy film of this invention is formed from the possible magnetic material of electroplating, and the soft magnetism alloy of Fe content magnetic

alloy especially a Fe-nickel system, or a Fe-Co system is used preferably.

[0012]In Fe system magnetic alloy, a plating magnetic alloy film carries out the eutectoid of the detailed high resistance material, changes, and raises the specific resistance of a plating magnetic alloy film by existence of high resistance material. A larger material of a magnetic alloy which has especially the big specific resistance of double or more figures than specific resistance, for example, an insulating material and semi-conductive material, is used for high resistance material. As for such high resistance material, what exists stably in a plating magnetic alloy film in the further below-mentioned electrolysis solution is preferred. Although it says distributing uniformly the particles of material with an eutectoid detailed in an alloy here, especially an eutectoid is a process of electrolysis plating, and the particle mixed into the deposited metal with the deposit of the metal from an electrolysis solution, and it has pointed out the thing of a metal layer and the particles of a detailed material to unify.

[0013]As such high resistance material, a metal oxide, a nitride, and carbide are mentioned preferably. As a metallic oxide, from an insulating material, it is stable in alumina, silica, a titania, zirconia, magnesia, and other electric field liquid, and an oxide material which is stability for a long period of time is available, for example. But the high resistance material can use a semi-conductive material, for example, the tin oxide, a zinc oxide, etc.

[0014]Especially the particle size of high resistance material is good for 100 nm or less to be 10 nm or less in consideration of the distribution gestalt of the thickness of a plating magnetic alloy film, and the high resistance material in the thickness, and the homogeneity in an electrolysis solution.

[0015]In the case of an insulating material, the content in the plating magnetic alloy film of high resistance material is weight %, and 0.5 to 2% of its range is preferred. In less than 0.5%, if the rise of resistance cannot be expected but it exceeds 2%, since other magnetic properties, for example, coercive force, will increase, it is not desirable.

[0016]The example of such a high resistance magnetic alloy film is shown in drawing 1, although it is very typical, but. A plating magnetic alloy film is formed of electroplating, and the plating magnetic alloy film after membrane formation has become that in which much high resistance material 4, for example, alumina **, carried out the eutectoid into the magnetic alloy film 3, after forming the plating foundation electrode 2 in this example on the substrate 1 decided according to a use.

[0017]The plating magnetic alloy film of this invention impresses a direct current or a pulse direct current as electroplating using the plating liquid which added the above-mentioned high resistance material, and the method of making an alloy film electrodeposit directly or indirectly on a substrate is adopted.

[0018]As an example of a plating magnetic alloy film, nickel-Fe alloy can be used as a magnetic alloy and the plating magnetic alloy film to which the eutectoid of the alumina was carried out can

be formed as high resistance material into the alloy film, for example. This high resistance nickel-Fe system plating magnetic alloy film can be used as a magnetic core material for thin film magnetic heads. The manufacturing method of such a magnetic alloy film adds alumina of detailed powder to the electrolysis solution which dissolved nickel and Fe, and plates it with high current density.

[0019]Although a direct current may be sufficient as the supply current for plating, electroplating is preferably performed using rectangular wave pulse current. Especially, to formation of the plating magnetic alloy film for thin film magnetic heads, rectangular wave pulse current is preferred. When carrying out electroplating to this use with high current density, if it carries out by direct current, in the case of the pattern formation for forming magnetic core shape, current density will become high by the end thru/or step of a plating conductor, and the plating layer in a conductor end will grow rapidly, and will follow unevenness on plating thickness, but. By ** considered as a pulse direct current of a square wave, even if there is the end thru/or step of a plating conductor, current density is made uniform and homogeneity can do plating thickness.

[0020]Although drawing 3 (A-E) shows an example of the process of forming the magnetic alloy film which constitutes a thin film magnetic head using electroplating, it forms about 0.1 micrometer of plating foundation electrode films 2 on the substrate 1, for example, a glass plate, (drawing 3 (A, B)). Subsequently, after forming the resist frame 5 of desired shape by photo lithography on the plating foundation electrode film 2 (drawing 3 (C)), within the plating tub with which the plating bath was filled, electroplating is performed by using a plating foundation electrode film as the negative pole, and self-possessed formation of the plating magnetic alloy film 3 is carried out (drawing 3 (D)). Dissolution removal of the resist frame 5 is carried out, and the desired pattern-shaped magnetic alloy film 3 is obtained (drawing 3 (E)).

[0021][Example 1] This example shows the manufacturing method of an alumina eutectoid Fe-nickel system plating magnetic alloy film. As nickel salt, nickel sulfate or nickel chloride was used underwater, and the ferrous sulfate was added to it as iron salt, and in this plating liquid, saccharin sodium was added as way acid and a stress relaxation agent, sodium lauryl sulfate was added as a surface-active agent as shock absorbing material, and it prepared in it. As liquid was in the acid range, pH adjustment was carried out, into plating liquid, it added 1%, the alumina material with a particle diameter of 10 nm or less was blended by weight, and it was considered as plating liquid.

[0022]Next, when performing electroplating, a plating foundation electrode film is used as the negative pole, and the seal of approval of the current is carried out between another electrodes in a solution. In electroplating, although carried out using a direct current, the pulse current of rectangular shape like another side and drawing 4 can also usually be used. In this example, 2.0 micrometers in thickness were obtained by pulse frequency [of 10 Hz], and pulse duty 20% by the current supply source of 20min at peak current density ² of 40mA/cm.

[0023]The amount of content alumina and electric and magnetic effect in the plating magnetic

alloy film of this plating method were investigated. Although drawing 5 shows the relation of the alumina content in the plating magnetic alloy film to the quantity of alumina in plating liquid, With the increase in the alumina addition in plating liquid, the alumina content in a plating magnetic alloy film increased, and alumina was contained about 2% in the plating magnetic alloy film in the range of the alumina addition in liquid shown in drawing 5.

[0024]Thus, the resistivity of the obtained plating-magnetic-alloy film due to the-alumina content in a film, If shown in drawing 7, the alumina content in a plating magnetic alloy film will follow on increasing, the resistivity of a plating magnetic alloy film will increase, and resistivity will improve with twice [about] with 2% of alumina content as compared with the thing of the content 0.

[0025]Although drawing 6 shows the relation of the alumina content in the film to the coercive force of a plating magnetic alloy film about the characteristic of others of a plating magnetic alloy film, coercive force increases as the alumina content in a plating magnetic alloy film increases. However, in alumina 2% of content, coercive force shows 160 or less A/m, and is a satisfactory level practical.

[0026]About the amplitude permeability of the plating magnetic alloy film, the high frequency characteristic of the amplitude permeability is compared with drawing 8 according to two kinds such as 0% of alumina content, and 2%. In this example, on low-pass [up to 10 MHz], although it is not dependent on frequency, if it becomes higher frequency exceeding 10 MHz, amplitude permeability will fall. In low-pass [up to 10 MHz], to alumina 0% of the thing, although amplitude permeability was low, the sample of 2% of alumina content had a small reduction of as opposed to frequency in the direction of the sample of 2% of content of amplitude permeability, and showed high amplitude permeability in a not less than 100-MHz high region.

[0027]Thus, in connection with high-specific-resistance-izing, improvement in the amplitude permeability by the side of high frequency was found by content of the alumina material. And when this above-mentioned alumina content plating magnetic alloy film was used as a thin film magnetic head core, the improvement in the characteristic by the side of the high frequency of head cores has been checked.

[0028]Although this example estimated with the alloy of nickel-Fe, As a result of forming a plating magnetic alloy film in a similar way also about the nickel-Fe-Co alloy which furthermore added Co, or Fe-Co alloy which excepted nickel from there, content into the film of alumina was accepted and resistivity also increased to the film of the content 0. The same effect as the thing of nickel-Fe alloy was able to be acquired also about the thin film magnetic head which formed the magnetic core using this plating magnetic alloy film.

[0029][Example 2] As a metallic-oxide material added in plating liquid, using silica, this example carried out the eutectoid of the silica for silica fines into neutral thru/or acid nickel within the limits and Fe content electrolytic water solution, similarly, performed electroplating and formed the plating magnetic alloy film of the nickel-Fe system alloy. Silica particle diameter used the thing

with a particle diameter of 20 nm or less. The magnetic alloy film was an alloy film with a thickness of 2.0 micrometers of a nickel-Fe system.

[0030]It evaluated like Example 1. When the silica content in plating liquid was made to increase, the content of the silica in a plating film also increased, and the plating magnetic alloy film of 5% or less of silica content was obtained, but the resistivity of the film at this time is a maximum of 80 microohm-cm, and their resistivity improved by about 2-times as compared with the plating magnetic alloy film of the silica content 0. The coercive force of the plating magnetic alloy film at this time was 160 or less A/m, and was a level which is satisfactory practically as a magnetic core.

[0031]Even if it used silica as a metallic oxide, it turned out similarly that the amplitude permeability of a plating magnetic alloy film by the side of high frequency improves by the effect by the membranous increase in resistivity, it uses as a thin film magnetic head magnetic core, and the characteristic in a high frequency region improves.

[0032]As a result of forming a plating magnetic alloy film in a similar way also not only about the alloy of nickel and Fe but about the nickel-Fe-Co alloy which added Co or Fe-Co alloy, content into the film of silica is accepted and resistivity also increases to the magnetic alloy film of 0% of content. The same effect as the thing of nickel-Fe alloy can be acquired also about the thin film magnetic head which formed the magnetic core using this plating magnetic alloy film.

[0033]

[Effect of the Invention]The plating magnetic alloy films of this invention are a magnetic alloy, the metallic oxide which carried out the eutectoid into the magnetic alloy, and that of *****, The specific resistance of a plating magnetic alloy film can be raised more than twice, thereby, eddy current loss can be reduced and a high frequency characteristic when especially used as a thin film magnetic head can be improved. The existence of a metallic oxide which carried out the eutectoid can control reduction of the amplitude permeability in a high frequency region, and can improve a high frequency characteristic.

[0034]Since these will be high specific resistance materials if the oxide which contains aluminum or silicon in the main ingredients is used for a metallic oxide, it is effective in an improvement of the specific resistance of a plating magnetic alloy film, and the amplitude permeability in a high frequency region. If magnetic alloy material makes it the alloy which contains either iron or cobalt at least as ferromagnetic metal, the magnetic high frequency characteristic of a soft magnetism alloy can be improved, and the high frequency characteristic especially outstanding as a magnetic core of a thin film magnetic head can be revealed. [nickel or cobalt]

[0035]On a substrate, the manufacturing method of this invention makes a magnetic alloy electrodeposit with electroplating, and is formed, it only electroplates in the magnetic alloy plating liquid which contains a metallic oxide or metal hydroxide in this case, and high specific resistance can be easily obtained on a plating magnetic alloy film.

[0036] Since it is alloy-plating liquid used in order that the magnetic alloy plating liquid of this invention may form a magnetic alloy film by electroplating on a substrate and a metallic oxide or metal hydroxide is contained in a magnetic metal ingredient water content solution, Only by electroplating this, the eutectoid of the metallic oxide is carried out into a plating magnetic alloy film, thereby, the specific resistance of a magnetic alloy film can be raised and a high frequency characteristic can be improved.

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the manufacturing method of the magnetic alloy film by electroplating, and the plating liquid used for it about the plating magnetic alloy film formed of electroplating. It is related with the magnetic alloy film used for the thin film magnetic head especially used for a magnetic recorder and reproducing device etc., and its magnetic core.

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PRIOR ART

[Description of the Prior Art] The magnetic thin film formed from electroplating is used for the thin film magnetic head used for a magnetic recorder and reproducing device etc., and its magnetic core. For example, as a magnetic core material of the recording part of a thin film magnetic head, nickel-Fe alloy of the presentation of nickel 80% - near 50% is used widely.

[0003] As the structure of the conventional thin film magnetic head shows drawing 2 the Records Department, the recording gap 22, the thin film coil 23, and the coil insulation layer 24 are formed on the common magnetic shielding 21, and the upper magnetic core 25 is formed. As for the upper magnetic core 25, the part is connected with the above-mentioned common shield 21, and the upper magnetic core 25 and the common shield 21 form the magnetic core for magnetic recording. The plating magnetic alloy film is applied when forming the common magnetic shielding 21 and the upper core 25 with a film method.

[0004] The thin film magnetic head used for it is also expected various highly efficient-ization with highly-efficient-izing of a magnetic disk drive. For example, the necessity of making it high asks for the write frequency for improvement in surface recording density, and it in this case, Since amplitude permeability falls remarkably, recording magnetic field strength falls and the phase lag of a generating magnetic field becomes remarkable by the eddy current loss in a magnetic material in a high frequency range, as for the thin film magnetic body, it is known that the recording characteristic of a magnetic head will deteriorate. In order to reduce eddy current loss, to insert an insulating layer between magnetic layers is validated as indicated by JP,08-102013,A.

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EFFECT OF THE INVENTION

[Effect of the Invention] The plating magnetic alloy films of this invention are a magnetic alloy, the metallic oxide which carried out the eutectoid into the magnetic alloy, and that of *****, The specific resistance of a plating magnetic alloy film can be raised more than twice, thereby, eddy current loss can be reduced and a high frequency characteristic when especially used as a thin film magnetic head can be improved. The existence of a metallic oxide which carried out the eutectoid can control reduction of the amplitude permeability in a high frequency region, and can improve a high frequency characteristic.

[0034] Since these will be high specific resistance materials if the oxide which contains aluminum or silicon in the main ingredients is used for a metallic oxide, it is effective in an improvement of the specific resistance of a plating magnetic alloy film, and the amplitude permeability in a high frequency region. If magnetic alloy material makes it the alloy which contains either iron or cobalt at least as ferromagnetic metal, the magnetic high frequency characteristic of a soft magnetism alloy can be improved, and the high frequency characteristic especially outstanding as a magnetic core of a thin film magnetic head can be revealed. [nickel or cobalt]

[0035] On a substrate, the manufacturing method of this invention makes a magnetic alloy electrodeposit with electroplating, and is formed, it only electroplates in the magnetic alloy plating liquid which contains a metallic oxide or metal hydroxide in this case, and high specific resistance can be easily obtained on a plating magnetic alloy film.

[0036] The magnetic alloy plating liquid of this invention is alloy-plating liquid used in order to form a magnetic alloy film by electroplating on a substrate.

Since a metallic oxide or metal hydroxide is contained in a magnetic metal ingredient water content solution, only by electroplating this, the eutectoid of the metallic oxide is carried out into a plating magnetic alloy film, thereby, the specific resistance of a magnetic alloy film can be raised and a high frequency characteristic can be improved.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, when manufacturing the magnetic core of a thin film magnetic head with electroplating, the method of making this insulating layer intervene is not practical. Only in electroplating, it is because the cascade screen of a magnetic alloy film and an insulator film cannot be built, so it will be used by turns, electroplating, and other insulator formation methods, for example, weld slag, and becomes very complicated on a process.

[0006] The specific resistance of an alloy of the above-mentioned nickel-Fe alloy is 20 - 40 microhm-cm, and the value is not large. For this reason, eddy current loss is large, and as mentioned above, for the improved efficiency in the high frequency range of a magnetic head, it is required that the resistivity of the plating magnetic alloy film which constitutes a magnetic core should be raised.

[0007] For this reason, this invention tends to provide the high plating magnetic alloy film of specific resistance with electroplating in view of the above-mentioned problem. The magnetic cores of the recording part of a thin film magnetic head are presented especially with this invention, and it tends to provide the magnetic alloy film it is large, and magnetic loss is small, and ***** excelled [film] in the magnetic properties in the high frequency region.

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MEANS

[Means for Solving the Problem] A plating magnetic alloy film of this invention is a plating magnetic alloy film formed on a substrate, and makes ***** with the feature metallic-oxide material in which a plating magnetic alloy film carried out the eutectoid into magnetic alloy material and magnetic alloy material. This magnetic alloy film raises specific resistance of the whole magnetic alloy film by carrying out the eutectoid of the metallic-oxide material finely into a magnetic alloy.

[0009] When it electroplates on a substrate, a manufacturing method of such a plating magnetic alloy film adds metallic-oxide material in plating liquid, and a plating layer is deposited simultaneously and it makes a magnetic alloy and metallic-oxide material it at a plating film. Plating liquid used for this manufacturing method adds metallic-oxide material further by using as the main ingredients what dissolved a constituent element of a magnetic alloy.

[0010] A high resistance plating magnetic alloy film of this invention can be widely used for other magnetic cells of thin film ferromagnetism as a magnetic shielding film as an object for reproduction of a magnetic head, or a magnetic core for record. A plating magnetic alloy film of this invention is used for the magnetic cores for record of a thin film magnetic head, and a magnetic alloy film forms a magnetic core it is large, and magnetic loss is small, and specific resistance excelled [magnetic core] in magnetic properties in a high frequency region.

[0011]

[Embodiment of the Invention] The plating magnetic alloy film of this invention is formed from the possible magnetic material of electroplating, and the soft magnetism alloy of Fe content magnetic alloy especially a Fe-nickel system, or a Fe-Co system is used preferably.

[0012] In Fe system magnetic alloy, a plating magnetic alloy film carries out the eutectoid of the detailed high resistance material, changes, and raises the specific resistance of a plating magnetic alloy film by existence of high resistance material. A larger material of a magnetic alloy which has especially the big specific resistance of double or more figures than specific resistance, for example, an insulating material and semi-conductive material, is used for high resistance material.

As for such high resistance material, what exists stably in a plating magnetic alloy film in the further below-mentioned electrolysis solution is preferred. Although it says distributing uniformly the particles of material with an eutectoid detailed in an alloy here, especially an eutectoid is a process of electrolysis plating, and the particle mixed into the deposited metal with the deposit of the metal from an electrolysis solution, and it has pointed out the thing of a metal layer and the particles of a detailed material to unify.

[0013]As such high resistance material, a metal oxide, a nitride, and carbide are mentioned preferably. As a metallic oxide, from an insulating material, it is stable in alumina, silica, a titania, zirconia, magnesia, and other electric field liquid, and an oxide material which is stability for a long period of time is available, for example. But the high resistance material can use a semi-conductive material, for example, the tin oxide, a zinc oxide, etc.

[0014]Especially the particle size of high resistance material is good for 100 nm or less to be 10 nm or less in consideration of the distribution gestalt of the thickness of a plating magnetic alloy film, and the high resistance material in the thickness, and the homogeneity in an electrolysis solution.

[0015]In the case of an insulating material, the content in the plating magnetic alloy film of high resistance material is weight %, and 0.5 to 2% of its range is preferred. In less than 0.5%, if the rise of resistance cannot be expected but it exceeds 2%, since other magnetic properties, for example, coercive force, will increase, it is not desirable.

[0016]The example of such a high resistance magnetic alloy film is shown in drawing 1, although it is very typical, but. A plating magnetic alloy film is formed of electroplating, and the plating magnetic alloy film after membrane formation has become that in which much high resistance material 4, for example, alumina **, carried out the eutectoid into the magnetic alloy film 3, after forming the plating foundation electrode 2 in this example on the substrate 1 decided according to a use.

[0017]The plating magnetic alloy film of this invention impresses a direct current or a pulse direct current as electroplating using the plating liquid which added the above-mentioned high resistance material, and the method of making an alloy film electrodeposit directly or indirectly on a substrate is adopted.

[0018]As an example of a plating magnetic alloy film, nickel-Fe alloy can be used as a magnetic alloy and the plating magnetic alloy film to which the eutectoid of the alumina was carried out can be formed as high resistance material into the alloy film, for example. This high resistance nickel-Fe system plating magnetic alloy film can be used as a magnetic core material for thin film magnetic heads. The manufacturing method of such a magnetic alloy film adds alumina of detailed powder to the electrolysis solution which dissolved nickel and Fe, and plates it with high current density.

[0019]Although a direct current may be sufficient as the supply current for plating, electroplating is

preferably performed using rectangular wave pulse current. Especially, to formation of the plating magnetic alloy film for thin film magnetic heads, rectangular wave pulse current is preferred. When carrying out electroplating to this use with high current density, if it carries out by direct current, in the case of the pattern formation for forming magnetic core shape, current density will become high by the end thru/or step of a plating conductor, and the plating layer in a conductor end will grow rapidly, and will follow unevenness on plating thickness, but. By** considered as a pulse direct current of a square wave, even if there is the end thru/or step of a plating conductor, current density is made uniform and homogeneity can do plating thickness.

[0020]Although drawing 3 (A-E) shows an example of the process of forming the magnetic alloy film which constitutes a thin film magnetic head using electroplating, it forms about 0.1 micrometer of plating foundation electrode films 2 on the substrate 1, for example, a glass plate, (drawing 3 (A, B)). Subsequently, after forming the resist frame 5 of desired shape by photo lithography on the plating foundation electrode film 2 (drawing 3 (C)), within the plating tub with which the plating bath was filled, electroplating is performed by using a plating foundation electrode film as the negative pole, and self-possessed formation of the plating magnetic alloy film 3 is carried out (drawing 3 (D)). Dissolution removal of the resist frame 5 is carried out, and the desired pattern-shaped magnetic alloy film 3 is obtained (drawing 3 (E)).

[0021][Example 1] This example shows the manufacturing method of an alumina eutectoid Fe-nickel system plating magnetic alloy film. As nickel salt, nickel sulfate or nickel chloride was used underwater, and the ferrous sulfate was added to it as iron salt, and in this plating liquid, saccharin sodium was added as way acid and a stress relaxation agent, sodium lauryl sulfate was added as a surface-active agent as shock absorbing material, and it prepared in it. As liquid was in the acid range, pH adjustment was carried out, into plating liquid, it added 1%, the alumina material with a particle diameter of 10 nm or less was blended by weight, and it was considered as plating liquid.

[0022]Next, when performing electroplating, a plating foundation electrode film is used as the negative pole, and the seal of approval of the current is carried out between another electrodes in a solution. In electroplating, although carried out using a direct current, the pulse current of rectangular shape like another side and drawing 4 can also usually be used. In this example, 2.0 micrometers in thickness were obtained by pulse frequency [of 10 Hz], and pulse duty 20% by the current supply source of 20min at peak current density ² of 40mA/cm.

[0023]The amount of content alumina and electric and magnetic effect in the plating magnetic alloy film of this plating method were investigated. Although drawing 5 shows the relation of the alumina content in the plating magnetic alloy film to the quantity of alumina in plating liquid, With the increase in the alumina addition in plating liquid, the alumina content in a plating magnetic alloy film increased, and alumina was contained about 2% in the plating magnetic alloy film in the range of the alumina addition in liquid shown in drawing 5.

[0024]Thus, the resistivity of the obtained plating magnetic alloy film due to the alumina content in

a film, If shown in drawing 7, the alumina content in a plating magnetic alloy film will follow on increasing, the resistivity of a plating magnetic alloy film will increase, and resistivity will improve with twice [about] with 2% of alumina content as compared with the thing of the content 0.

[0025]Although drawing 6 shows the relation of the alumina content in the film to the coercive force of a plating magnetic alloy film about the characteristic of others of a plating magnetic alloy film, coercive force increases as the alumina content in a plating magnetic alloy film increases. However, in alumina 2% of content, coercive force shows 160 or less A/m, and is a satisfactory level practical.

[0026]About the amplitude permeability of the plating magnetic alloy film, the high frequency characteristic of the amplitude permeability is compared with drawing 8 according to two kinds such as 0% of alumina content, and 2%. In this example, on low-pass [up to 10 MHz], although it is not dependent on frequency, if it becomes higher frequency exceeding 10 MHz, amplitude permeability will fall. In low-pass [up to 10 MHz], to alumina 0% of the thing, although amplitude permeability was low, the sample of 2% of alumina content had a small reduction of as opposed to frequency in the direction of the sample of 2% of content of amplitude permeability, and showed high amplitude permeability in a not less than 100-MHz high region.

[0027]Thus, in connection with high-specific-resistance-izing, improvement in the amplitude permeability by the side of high frequency was found by content of the alumina material. And when this above-mentioned alumina content plating magnetic alloy film was used as a thin film magnetic head core, the improvement in the characteristic by the side of the high frequency of head cores has been checked.

[0028]Although this example estimated with the alloy of nickel-Fe, As a result of forming a plating magnetic alloy film in a similar way also about the nickel-Fe-Co alloy which furthermore added Co, or Fe-Co alloy which excepted nickel from there, content into the film of alumina was accepted and resistivity also increased to the film of the content 0. The same effect as the thing of nickel-Fe alloy was able to be acquired also about the thin film magnetic head which formed the magnetic core using this plating magnetic alloy film.

[0029][Example 2] As a metallic-oxide material added in plating liquid, using silica, this example carried out the eutectoid of the silica for silica fines into neutral thru/or acid nickel within the limits and Fe content electrolytic water solution, similarly, performed electroplating and formed the plating magnetic alloy film of the nickel-Fe system alloy. Silica particle diameter used the thing with a particle diameter of 20 nm or less. The magnetic alloy film was an alloy film with a thickness of 2.0 micrometers of a nickel-Fe system.

[0030]It evaluated like Example 1. When the silica content in plating liquid was made to increase, the content of the silica in a plating film also increased, and the plating magnetic alloy film of 5% or less of silica content was obtained, but the resistivity of the film at this time is a maximum of 80 microomegacm, and their resistivity improved by about 2 times as compared with the plating

magnetic alloy film of the silica content 0. The coercive force of the plating magnetic alloy film at this time was 160 or less A/m, and was a level which is satisfactory practically as a magnetic core.

[0031]Even if it used silica as a metallic oxide, it turned out similarly that the amplitude permeability of a plating magnetic alloy film by the side of high frequency improves by the effect by the membranous increase in resistivity, it uses as a thin-film magnetic-head magnetic core, and the characteristic in a high frequency region improves.

[0032]As a result of forming a plating magnetic alloy film in a similar way also not only about the alloy of nickel and Fe but about the nickel-Fe-Co alloy which added Co or Fe-Co alloy, content into the film of silica is accepted and resistivity also increases to the magnetic alloy film of 0% of content. The same effect as the thing of nickel-Fe alloy can be acquired also about the thin film magnetic head which formed the magnetic core using this plating magnetic alloy film.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] The typical sectional view of the plating magnetic alloy film of this invention is shown.

[Drawing 2] The section schematic diagram of the Records Department of a thin film magnetic head.

[Drawing 3] The sectional view (A-E) showing the process of manufacturing a plating magnetic alloy film.

[Drawing 4] The figure showing the shape of a pulse plating current.

[Drawing 5] The figure showing the relation between the alumina addition in the plating liquid in the example of this invention, and the alumina content in the plating magnetic alloy film which formed membranes.

[Drawing 6] The figure showing the alumina content in the plating magnetic alloy film of this invention, and the relation of resistivity.

[Drawing 7] The figure showing the alumina content in the plating magnetic alloy film in the example of this invention, and the relation of coercive force.

[Drawing 8] The figure showing the frequency characteristic of the amplitude permeability of the plating magnetic alloy film of this invention.

[Description of Notations]

- 1 Substrate
- 2 Plating foundation electrode
- 3 Plating magnetic alloy film
- 4 Oxide

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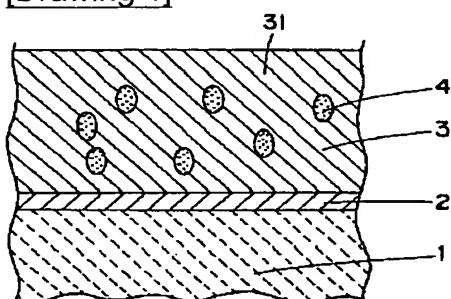
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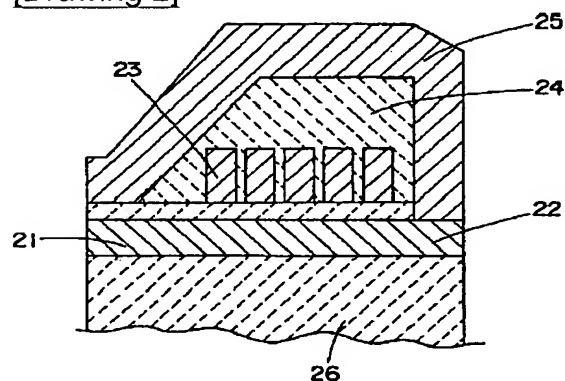
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DRAWINGS

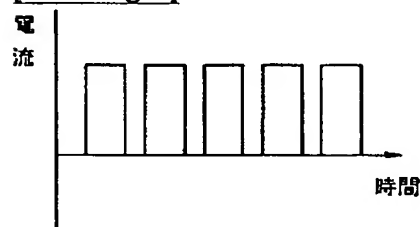
[Drawing 1]



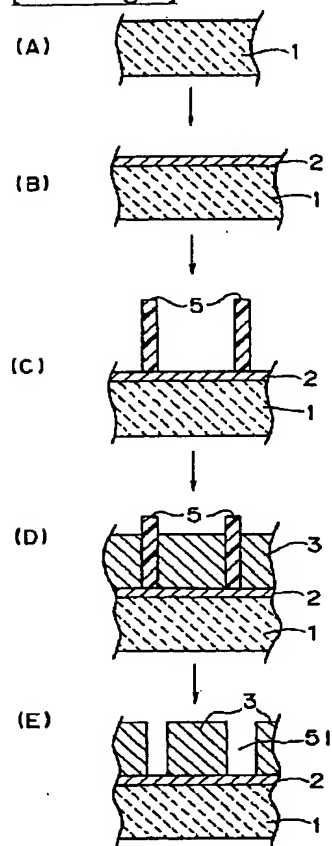
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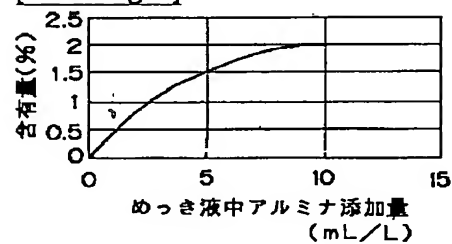
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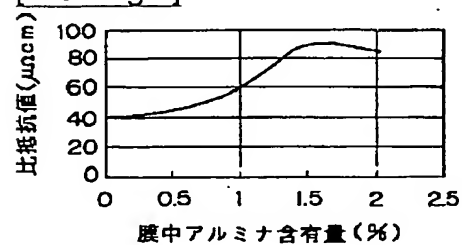
[Drawing 3]



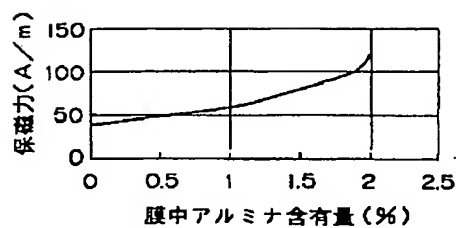
[Drawing 5]



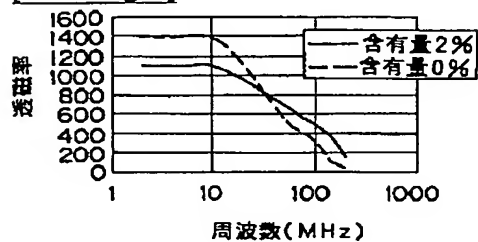
[Drawing 6]



[Drawing 7]



[Drawing 8]



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